Math 211: Ordinary Differential Equations

(draft version : last updated : 2019–07–26)

Disclaimer

The information contained in this syllabus, other than the absence policy, is subject to change with reasonable advance notice.

Course Information

Course Logistics

Class time	:	Monday – Friday, 10h30 – 12h00
Class room	:	George R. Brown Hall (GRB) W211 (2F)
Office hours	:	Tuesday : 14h30 – 15h45 ; Thursday : 16h30 – 17h45

Instructor Information

Instructor	:	Stephen Wolff
Office	:	HBH 038 (basement)
E-mail	:	Stephen.Wolff@rice.edu

Textbook

This course is based on the following textbook:

- *Differential equations and linear algebra*, 2nd edition, by Farlow, Hall, McDill, & West

We will wrestle with the following topics (numbers refer to chapters in Farlow et al.):

1. First-order ODEs
2. Linearity
3. Linear algebra
4. Higher-order linear ODEs
5. Linear transformations
6. Linear systems
7. Nonlinear systems
8. Laplace transforms

You are not required to purchase a copy of the textbook. Your understanding will be well served if you secure access to material covering the topics listed above.

Grading Policy

We will assess progress using the following tools:

1. Homework (H). There will be homework assigned daily. Homework is due promptly by 10h35 the following class. Late homework will not be accepted. Homework will be graded using a "reasonable attempt" rubric.

2. Quizzes (Q). There will be an in-class quiz every day. Quizzes come in two flavors: short quizzes (SQ) and long quizzes (LQ). Short quizzes are 1- or 2-minute quizzes on key concepts (to help clarify key ideas). Long quizzes are 5- to 15-minute quizzes asking you to work on an exercise (exam practice). You have the opportunity to retake long quizzes.

3. Exams (E). There will be three midterm exams (ME) and one final exam (FE). Each exam will be cumulative. The final day of classes, each student will have a 20–30 minute oral exam — a chat, really. See page 4 for exam dates.

4. LaTeX project (L). There will be one team project. Your team will solve past exam questions and typeset your solutions. I will provide a template and assistance.

How your grade is calculated. Your final average is allocated among the above tools as follows: H : 10% ; SQ : 10% ; LQ : 10% ; each ME : $\frac{40}{3}$% ; L : 10% The final exam applies to the remaining 20% plus any yet-unsecured part of the other 80% (except the team project).

For example, suppose that prior to the final exam, you submit all homework, earn an average of 50% on both types of quizzes, score 75% on each midterm exam, and earn 80% on the LaTeX project. Then you have secured (denoting final-grade % by P)

$$\underbrace{100\% \times 10\text{P}}_{\text{H}} + \underbrace{50\% \times 10\text{P}}_{\text{SQ}} + \underbrace{50\% \times 10\text{P}}_{\text{LQ}} + \underbrace{3 \times \left(75\% \times \frac{40}{3}\text{P}\right)}_{\text{ME}} + \underbrace{80\% \times 10\text{P}}_{\text{L}} = 60\text{P}.$$

The final exam is worth 40 P (20 P plus the unsecured $5\text{P} + 5\text{P} + 3 \times (25\% \times \frac{40}{3}\text{P}) = 20\text{P}$ from all non-L components).

Absence Policy

Class attendance is strongly encouraged but not required. We are old enough to accept responsibility for our actions and decisions.

Rice Honor Code

As a student at Rice University, you pledge to uphold the Rice Honor Code, which you can find in the Honor System Handbook.

On homework, all resources are permitted. In particular, you are strongly encouraged to work with one another. The purpose of homework is to help you to learn and internalize the material.

On quizzes and exams, no external resources are permitted, unless the instructor explicitly indicates otherwise. The purpose of quizzes and exams is to help you to see what you can do so far and identify what to work on.

Students with Disabilities

Any student with a documented disability that requires accommodation is encouraged to contact both the course instructor (Stephen.Wolff@rice.edu) and the Rice Disability Resource Center (adarice@rice.edu; Allen Center, Room 111).

Course Objectives and Expected Learning Outcomes

By the end of this course, you should know how to

- Analyze and create direction fields.
- Analyze the existence and uniqueness of solutions to ODEs and linear systems.
- Use the superposition and nonhomogeneous principles, and where they apply.
- Use techniques for solving first-order ordinary differential equations (ODEs).
- Use fundamental concepts in linear algebra, including the determinant, Gauss–Jordan reduction algorithm, rank–nullity theorem, eigenvalues and eigenspaces.
- Analyze second-order ODEs, including the characteristic equation and equivalent linear system.
- Analyze linear systems of first-order ODEs.
- Analyze and create phase portraits of linear systems.
- Linearize nonlinear systems of first-order ODEs, and why.
- Use the Laplace transform to solve ODEs.

Resources

Potentially helpful resources:

- Past exams are hosted on the Calculus Resources page on Canvas. See the page "Math Exam Help" for log-in instructions. (You will need a valid Rice NetID.)

Calendar

Below is a preliminary schedule of topics. Section numbers and exercise numbers refer to Farlow et al. (2e) unless indicated otherwise. Exercises are *assigned* on the date of the line on which they appear and are *due* the next class.

Day	Date	Topics	Sections	Exercises
M	08 Jul	Diagnostic quiz; Modeling; Slope fields	1.1–1.2	1.2.03,07,16–21,39
T	09 Jul	Separation of variables; Numerical methods	1.2–1.4	1.2.05,65;1.3.07,09,17,23
W	10 Jul	Numerical methods; Existence, uniqueness	1.4–1.5	1.3.25–30;1.4.05;1.5.01,05
R	11 Jul	Vector spaces; Linear equations	1.5,2.1	1.5.09,15,17;2.1.03,09,27,37,45
F	12 Jul	Applications	2.2–2.4	2.2.03,23;2.3.07;2.4.07
M	15 Jul	Applications; Phase line	2.2–2.5	2.2.47;2.5.1,3,22,24,36
T	16 Jul	Bifurcation; Review; Matrices	2.5,3.1	3.1.7,13,25,59
W	17 Jul	Matrices; Row reduction	3.1–3.2	3.2.25,62
W	**17 Jul**	**Exam 1 (p.m.)**	**1.1–2.5**	
R	18 Jul	Row reduction; Matrix inverse	3.2–3.3	3.2.33,46;3.3.07,22
F	19 Jul	Determinant; Vector spaces	3.4–3.6	3.4.03,15,35;3.5.13,19,25,41;3.6.49–53
M	22 Jul	Linear maps; Eigendinge	5.1–5.3	3.6.21,32;5.1.35,37;5.2.31,37,70
T	23 Jul	Eigendinge; Diagonalization; Review	5.3–5.4	5.3.13,15,21,31,37*;5.4.31,33,49*
W	24 Jul	Undetermined coefficients;	4.4	4.4.25,33,45;
		Variation of parameters	4.5	4.5.3,13
W	**24 Jul**	**Exam 2 (p.m.)**	**1.1–5.4**	**(no Chapter 4)**
R	25 Jul	Higher-order ODEs; Linear systems	6.1–6.3	6.1.7,17,19
F	26 Jul	Real and complex eigenvalues	4.2–4.3	4.2.7,9,21;4.3.1,3,13,19;
			6.2–6.3	6.2.19,21,23,25;6.3.3,13
M	29 Jul	Trace–determinant plane	6.4	6.2.5–8;6.4.1–6
T	30 Jul	Decoupling; Matrix exponential; Review	6.5–6.6	6.5.1,13;6.6.1,11,15
W	31 Jul	Nonhomogeneous linear systems	6.7	
W	**31 Jul**	**Exam 3 (p.m.)**	**1.1–6.6**	
R	01 Aug	Nonlinear systems; Linearization	7.1–7.2	
F	02 Aug	Laplace transform	8.1–8.2	LaTeX project
M	05 Aug	Delta functions; Convolution	8.2–8.4	
T	06 Aug	Solutions with Laplace; Qualitative theory	8.5	Practice exam (*Sem YYYY*)
W	07 Aug	Review	All	
R	**08 Aug**	**Final exam (in-class)**	**1.1–8.5**	
F	**09 Aug**	**Oral exam (a.m. & p.m.)**	**1.1–8.5**	